NASA Transition Overview

Exploration Systems and Space Operations Mission Directorates

Dr. John Olson (NASA HQ - ESMD)
Mr. Joel Kearns (NASA HQ - SOMD)

March 4, 2008

U.S. Space Exploration Policy

Foundations for Exploration & Change

Vision For Space Exploration

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NASA Authorization Act of 2005

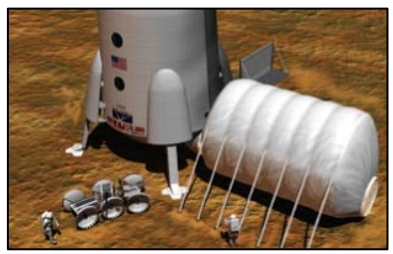
Global Exploration Strategy Themes

Human Civilization

Global Partnerships

Scientific Knowledge

Economic Expansion



Exploration Preparation

Public Engagement

What is NASA Transition?

NASA Transition Definition:

- **The careful planning, optimized utilization, and responsive disposition of processes, personnel, resources, and real and personal property, focused upon leveraging existing Shuttle and ISS assets for Exploration programs' safety and mission success**

A Continuum of Transition and Recurring Development to Operations Iterations:

- **Space Shuttle Program Transition & Retirement (T&R)**
- **ISS Program Shuttle Transition and Retirement (STaR)**
- **Constellation Transition(s) from Development to Operations**
- **Commercial Orbital Transportation Services (COTS) Transition**

Shuttle

ISS

COTS

Ares I

Orion

Ares V

Focus on Big 3: Workforce, Infrastructure/Property, Budget/Schedule

CONFIGURATION CONTROLLED DOCUMENT

Document # MPIM-rev-2008-01-25-04

revised January 25, 2008

Controlling Officials: Joel Kearns (HQ/SOMD), John Olson (HQ/ESMD)

Multi-Program Integrated Milestones

Legend: Shuttle Flight; uncrewed COTS flight; uncrewed/crewed Constellation Flight; ? facility utilization TBD; X no further facility utilization identified

CY 2008 (FY 2008 Q2–Q4) | CY 2009 (FY 2009 Q1–Q4) | CY 2010 (FY 2010 Q1–Q3) | FY 2011 | FY 2012 | FY 2013 | FY 2014 | FY 2015 | FY 2016 | FY 2017 | FY 2018 | FY 2019 | FY 2020

Lunar Reconnaissance Orbiter

ISE Missions: Human Lunar Return

International Space Station

International Partners — Soyuz, Progress, ATV, HTV

Int'l Partners — Soyuz, Progress, ATV, HTV

NOTE: Orions 7 and 8 and COTS are contingent on ISS end-of-life date and potential for continuing U.S. ISS ops

NOTE: Orions 9 and 10 and COTS are contingent on continuing U.S. ISS ops

NOTE: Orions 11 and 12 and COTS are contingent on continuing U.S. ISS ops

NOTE: Orions 14 and 16 and COTS are contingent on continuing U.S. ISS ops

NOTE: Orions 18 and 20 and COTS are contingent on continuing U.S. ISS ops

NOTE: The potential for ISS operations from 2016 – 2020 is under review

Six person crew capability

Assembly complete

Russian purchasing authority ends

NOTE: ULF4 and ULF5 are manifested as contingency ISS logistics flights.

Space Shuttle

12A.1 | 13A | 13A.1 | 10A | 1E | 1JA | 1J | HST SM4 | UF2 | 1R | 2JA | 17A | ULF3 | 20A | 19A | ULF4 | ULF5

116 | 117 | 118 | 120 | 122 | 123 | 124 | 125 | 126 | 119 | 127 | 128 | 129 | 130 | 131 | 132 | 133

Last SSME on-dock at KSC

NOTE: Atlantis retirement under review.

Atlantis retired

Last ET on-dock at KSC

Discovery retired

Endeavour retired

COTS

SpaceX: Demo 1 PDR; Demo 1 CDR; Financing round 2; Demo 3 SRR; Financing round 1; Demo 3 PDR; Demo 2 SRR; Demo 2 PDR; Demo 2 CDR; SpaceX Demo 1; Financing round 3; Demo 3 CDR; SpaceX Demo 2; SpaceX Demo 3; IOC

RpK: Alternate Provider

Facilities

SSP last-need for O&C

SSP last-need for A-1

SSP last-need for LCC Firing Room 1; transfer to Cx for modifications

A-1 ready for Cx testing

LC-39B configuration for last SSP flight off pad

SSP last-need for MLP 1

SSP last-need for VAB HB 2

LC-39B and MLP 1 configuration for Ares I-X

SSP last-need for A-2

A-2 ready for Cx testing

SSP last-need for VAB HB 4

SSP last-need for VAB HB 3

SSP last-need for MLP 2

SSP last-need for VAB LB and HB 1

SSP last-need for CT 1 and 2

SSP last-need for MLP 3

A-3 ready for Cx testing

SSP last-need date for LC-39A

SSP last-need for OPF 1,2, and 3

LC-39B configuration for Ares I-Y

LC-39A configuration for Ares V

Constellation

Sub-Orbital: Pad Abort 1; Ares I-X 4 seg 1st stage, dummy u/s; AA-1 transonic; Pad Abort 2; AA-2 max-q; AA-3 tumble; Ares I-Y 5 seg 1st stage, dummy u/s

NOTE: Sub-orbital test flights prior to Orion 1 subject to change with test experience and funding requirements.

Orion 1 — 5 seg 1st stage, active u/s, active Orion capsule

Orion 2 — IOC test flight, LIDS

Orion 3 — test flight, LIDS

Orion 4 — FOC

Orion IOC

Ares V-Y

Altair 1 / Orion 13

Altair 2 / Orion 15

Altair 3 / Orion 17

Altair 4 / Orion 19

Initial Capability (IC) Level 1 SRR | IC Level 1 SDR | IC Level 1 PDR 1 | IC Level 1 PDR 2 | IC Level 1 CDR | IC Level 1 SAR

Orion SRR | Orion SDR | Orion pre-NAR | Orion PDR | Orion CDR | Orion DCR and SAR

Ares I SRR | Ares I-X PDR | Ares I SDR and pre-NAR | Ares I PDR and NAR | Ares I CDR | Ares I UIS DCR

J-2X SRR | J-2X PDR | Ares I-X CDR | J-2X CDR | Ares I UIS CDR | J-2X MPTA UIS need date | J-2X DCR | Ares I DCR

Ares I 1st stage SRR | Ares I UIS SRR | Ares I UIS SDR | Ares I UIS PDR | Ares I 1st stage PDR | Start of J-2X testing on A3 | Ares I 1st stage CDR | Ares I 1st stage DCR

Lunar Capability (LC) Level 1 SRR | LC Level 1 SDR | LC Level 1 PDR | LC Level 1 CDR | LC Level 1 SAR

Ares V project SRR | Ares V project PDR | Ares V project CDR | Ares V project DCR

Altair project SRR | Altair project PDR | Altair project CDR | Altair project DCR

NOTE: The shadowed Orion 2 IOC flight in 2013 is the programmatic manifest date at the 53% confidence level. The bold Orion IOC in 2015 flight is the current Agency commitment at the 65% funding confidence level for the flight manifest.

NOTE: Reusable Solid Rocket Motor segment production

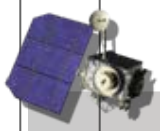
RSRM

0 Constellation 35 Shuttle | 5 Constellation 35 Shuttle | 10 Constellation 35 Shuttle | 10 Constellation 0 Shuttle | 12 Constellation | 13 Constellation | 15 Constellation | 15 Constellation | 15 Constellation | 19 Constellation | 27 Constellation | 31 Constellation | 36 Constellation | 41 Constellation

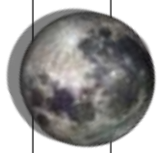
www.nasa.gov/transition

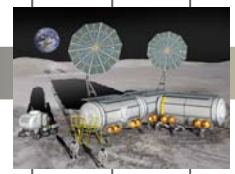
Exploration Roadmap

05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25



Exploration and Science Lunar Robotics Missions





Lunar Outpost Buildup

Research and Technology Development on ISS

Commercial Crew/Cargo for ISS

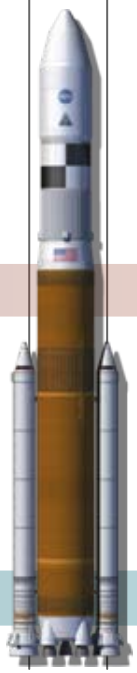
Space Shuttle Operations

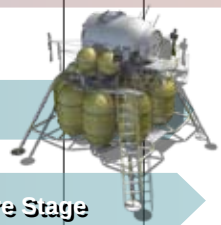
SSP Transition

Ares I and Orion Development

Operations Capability Development
(EVA Systems, Ground Operations, Mission Operations)

Orion and Ares I Production and Operation





Altair Lunar Lander Development

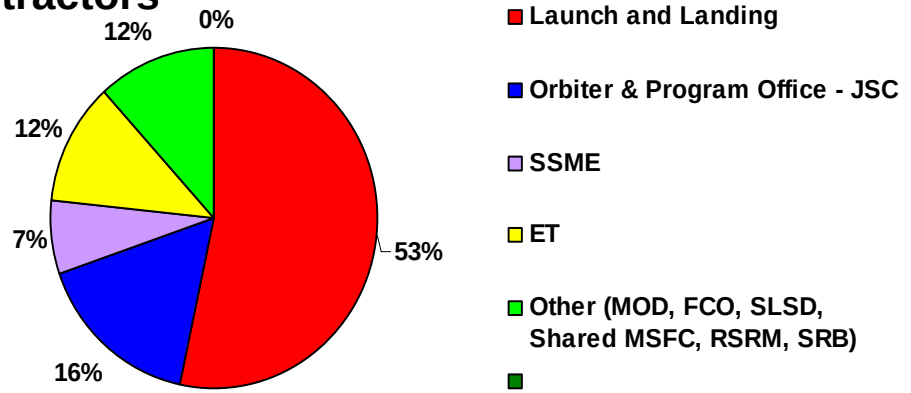
Ares V & Earth Departure Stage

Surface Systems Development

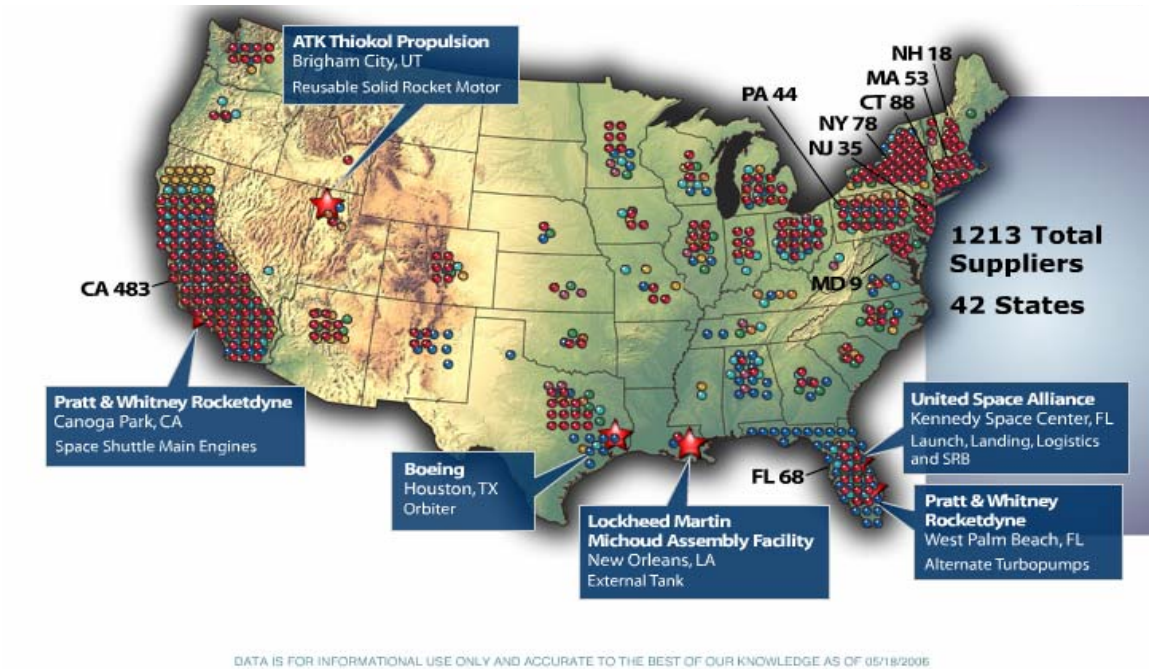
Scope of the Transition Challenge:
Shuttle and ISS Flight Safety is #1 Priority

- Approximately 17,000 civil servants and contractors*
- Shuttle occupies 654 facilities
- Over 980,000 equipment line items
- Total equipment acquisition value is ~$12B
- Total facilities replacement value is ~$5.7B
- 1,500+ Suppliers: 2007 Key for ET, SSME, Element Suppliers

Equipment Items Composition

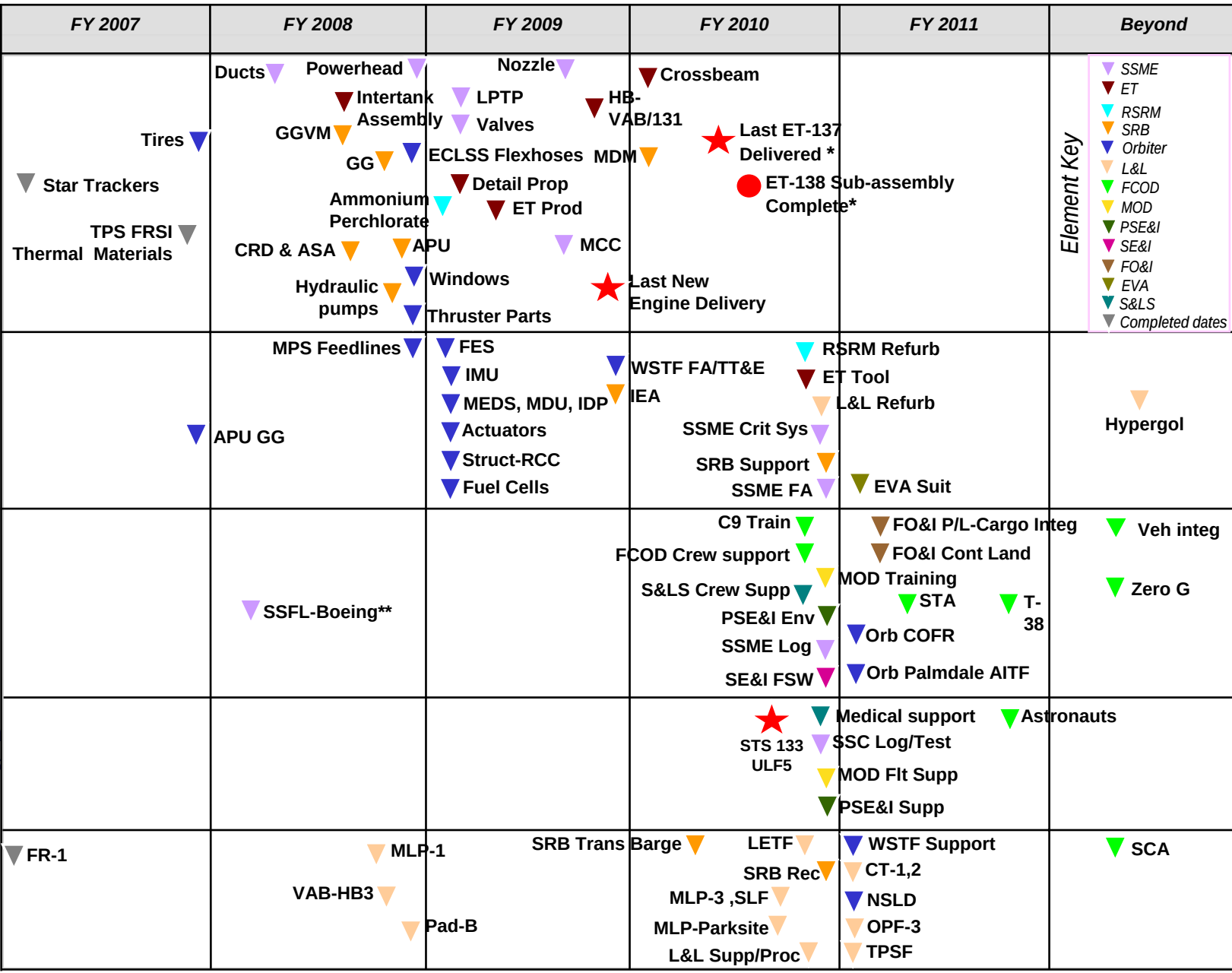


* FY07 workforce data from SOMD RMO, 2/15/07



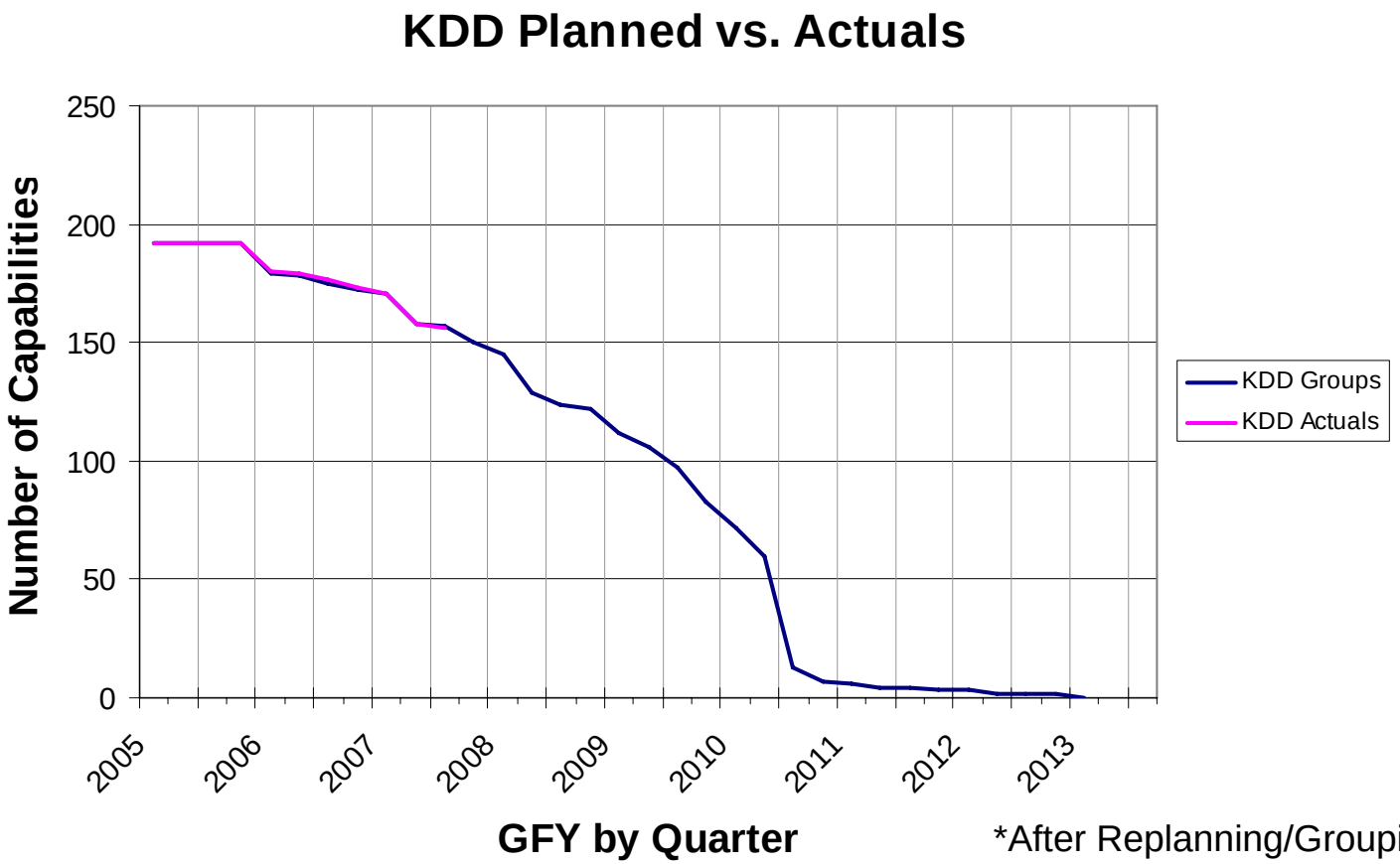
Color Code of Suppliers to Shuttle Prime Contractors:
Yellow - Boeing
Dark Blue - USA
Purple - Lockheed-Martin
Green - Hamilton Sunstrand
Blue - PWR
Orange - ATK
Red - Orbiter Project (JSC)

Shuttle Transition Strategic Capabilities
Last Need Milestones



*Currently under review **NASA Facility LND Completed in FY2006 and currently being released

SSP Strategic Capabilities Assessment (SCA)
Key Decision Date (KDD) Burn Down



*After Replanning/Grouping

NASA is on Target with the Plan to Retire the Shuttle by 2010 and Transition to Constellation

Capability: a bounded function performed for the SSP; Comprised of workforce; facilities/equipment, suppliers and contracts that together perform a high-level function (e.g. SSME HPOT manufacturing).

SCA Key Decision Date: date at which a disposition decision is needed in order to promptly begin capability, phase out at its last need date. Timed to minimize unnecessary expense incurred by maintaining capabilities no longer required.

Space Shuttle to Constellation Coordination

- **Launch Processing Transition Synergy**

  SRB stacking operations in the VAB in support of Ares 1-X

  Ares I project requested that each solid rocket booster be stacked sequentially to quantify and observe the potential deflection caused in the MLP due to forces inflicted by a single booster assembly. *Accomplished for STS-118 and STS-120*

- **Paperless System**

  Powered up Shuttle OV-103 Discovery using a paperless system planned for use on Orion and Ares. *Accomplished for STS-120*

- **SSP-CxP Manufacturing Plan Integration - MAF Utilization**

  Phased transition of MAF floor space and tooling to CxP (Ares I US and Orion)

  Coordination by SSP and CxP (and ET and Ares I US) in work to identify detailed issues, conflicts, resolution *In Work – Near Term Meetings Planned*

- **SSP-CxP Manifest Integration – Launch Processing Integration**

  As CxP progresses to Ares 1-X, coordination and integration of the Space Shuttle manifest for KSC Facilities Usage (e.g. VAB High Bays) becomes more important.

  SSP Manifest assessments/options being integrated with CxP Planning & vice versa

  CxP Test Events in Shuttle Master Schedule

Transition is Occurring Now – Results are Good

Transition Example: SSP RSRB Project

RSRB Today

RSRM

SRB

Nose Cap

Frustum Parachutes

Forward Skirt

Forward Segment

Forward-Center Segment

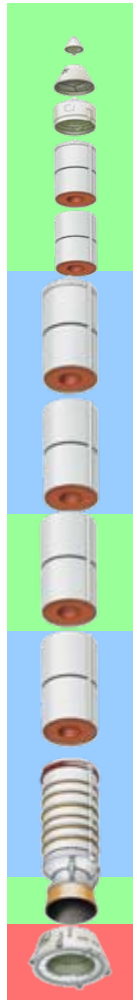
Aft-Center Segment

Aft Segment

Nozzle Assembly Aft Skirt Assembly

RSRB End State — Transfer to Constellation or Excess

Ares I First Stage



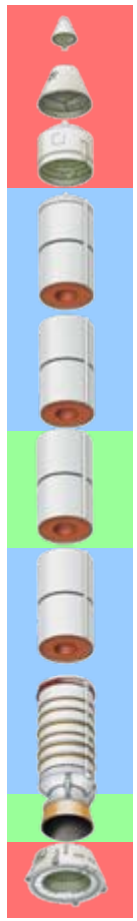
New Forward Structures Including Forward Skirt

New Parachutes

New Center-Center Segment

Redesigned Nozzle

Ares V Booster



New Parachutes

New Center-Center Segment

Redesigned Nozzle

SSP Excess

4-Segment Parachutes

Avionics and Cables

Some Nozzle and Flex Bearing Hardware

Major Space Shuttle Program Facilities

Reusable Solid Rocket Motor
ATK Thiokol Propulsion
Brigham City, Utah

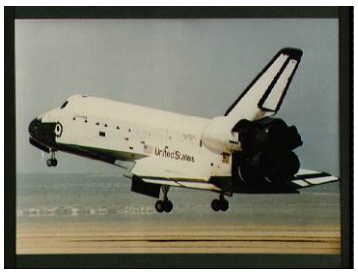
NASA MSFC
Huntsville, AL
-Shuttle Projects Office
-SSME - ET
-SRB - RSRM

Space Shuttle
Main Engines
Pratt & Whitney/Rocketdyne
Canoga Park, CA

EVA Suits
Hamilton Sundstrand
Winsor Locks, CT

NASA Headquarters
Washington, D.C.

NASA KSC
Kennedy Space Center, FL
-Launch & Landing
-NASA Shuttle Log. Depot
-Solid Rocket Booster
- United Space Alliance (USA)



Alternate Landing Site
Edwards AFB, CA

NASA JSC
Houston, Texas
-Shuttle Program Office
-Program Integration
-Space Shuttle Veh. Eng. Office
(FSW, FCE, ORB, RMS)
-United Space Alliance - SFOC

External Tank
LMCO
Michoud Assembly Fac.
New Orleans, LA

NASA SSC
Bay St. Louis, MS
- SSME Test

Alternate Turbo Pumps
Pratt & Whitney
West Palm Beach, FL

Leveraging the Ares I and Ares V Heritage: Strategic and Tactical Implications

- J-2 engine (Ares I and Ares V)
- Operational experience

Emphasize Life Cycle Cost and Risk Control

- RSRM / SRB production (Ares I and Ares V)
- External Tank fabrication facilities (Ares I, and Ares V)
- Ground processing facilities
- Mission operations facilities
- Operational experience

Saturn V


Space Shuttle

Ares I

Ares V

NASA Transition Driving Paradigm Changes

- **Focus Change:** NASA is moving our HSF workforce from Shuttle and ISS operations work to CxP design and development; Will spend the same amount on skilled labor, but with an emphasis on design of new vehicles to explore beyond low earth orbit. **Leaner Across the Board, More Development**

- **Reduce Fixed & Ops Costs:** New vehicles must cost less to operate, or we cannot afford to develop the vehicles to explore beyond earth orbit. Must drop production, processing and operations costs.

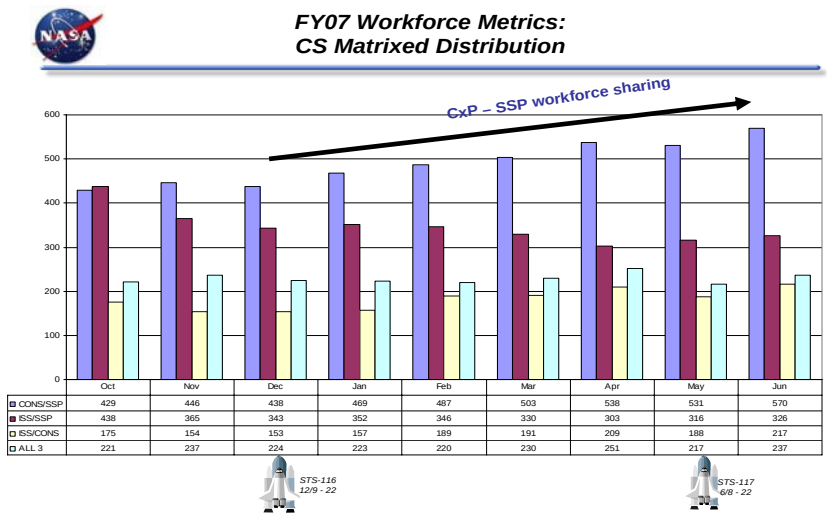
- **Geographical & Skill Shifts:** Regional workforce impacts of shifting from "vehicle processing" and "operations" to DDTE are becoming clearer. Reducing the impacts to specific regions will require assignment of specific Constellation development, test & manufacturing as Shuttle is completed.

- **Budget Threat:** Still defining post Shuttle Fly-Out asset disposition work -- Funds spent on Shuttle T&R come from Exploration DDTE. Asset Disposition costs to be minimized.

Transition Is About Re-Invention and Re-Invigoration of NASA

Transition and the Workforce

- **Unique Challenges:**
  - ***Retaining Skills for Shuttle Operations*** to Safely Execute Remaining Shuttle Missions; ***and***
  - ***Managing Transition*** of Appropriate Shuttle Workforce into Constellation Development; ***and***
  - ***Retaining Skills during Gap*** to Safely Execute Constellation IOC Flight Operations (2010-15)
  - **Balancing "10 Healthy Centers" with Program Requirements drive Workforce and Skill Needs**
- **NASA is Committed to Transitioning as Much of the Shuttle Civil Service Workforce to Other Agency Programs as is Practical, Using Strategies such as:**
  - **Workforce Sharing, Matrixing, Detailing. Retraining, Skills Assessment and Org Matching**
- **NASA is Committed to Working with Shuttle Contractor Partners on Workforce Issues.**
  - **Industry has a Range of Transition, Retention, and Staffing Tools Available to Maintain Critical Skills to Meet their Contractual Obligations Required for Shuttle Mission Execution.**
  - **Unique to Each Contractor Situation and their Known Role in Future Constellation Work**



Facilities Transition Already Occurring

- KSC / Operations & Checkout Building
  - Highbay for all Orion final assembly
  - Highbay cleanout Complete
  - Highbay design in work

- **KSC / Pad 39B**
  - Launch Pad and Support Facilities
  - Lightning Protection System

- **Michoud Assembly Facility (MAF)**
  - Primary structure manufacturing
  - Composite and metal fabrication
  - Planned Users: Orion, Ares I Upper Stage, Ares V Earth Departure Stage, Ares V Core Stage, COTS

Transition is Occurring Now – Initial Results are Good!

Constellation Leverages Unique Skills and Capabilities Throughout NASA Centers

Dryden
- Lead Abort Flight Test Integration/Operations
- Abort Test Booster procurement
- Flight Test Article Development/ Integration

Ames
- Lead Thermal Protectio System ADP
- Aero-Aerothermal database
- Ares Abort simulations
- Software and GN&C support

Glenn
- Lead Service Module and Spacecraft Adapter integration
- Flight Test Article “Pathfinder” fabrication
- Ares I-1 upper stage simulator lead
- Ares power, TVC and sensors lead
- J-2X altitude/inspace testing
- SE&I Support
- EVA Power, Communications, Avionics, and Informatics Lead

Goddard
- Communications Support

Langley
- Lead Launch Abort System integration
- Lead landing system ADP
- Ares I-1 vehicle integration
- Ares aerodynamics lead
- SE&I Support

JPL
- Thermal Protection System support

Kennedy
- Home for Ground Ops Project
- Ground processing
- Launch operations
- Recovery operations

Johnson
- Home for Program
- Home for Projects: Orion, Mission Ops, EVA, Lunar Lander
- Lead Crew Module integration
- Orion Spacecraft Integration
- GFE projects management
- Flight Test Program

Stennis
- Rocket Propulsion Testing for Ares

Marshall
- Home for Ares Project
- Ares I and V development and integration lead
- LAS and SM SE&I Support

Open Exploration Architecture: Pieces of a Greater Mission

Planning & Support for Human Missions to the Moon & Beyond

US (NASA+Industry)-Developed Initial Capabilities

- Launch Vehicle Architecture
- Lunar Lander: ascent vehicle, descent vehicle, basic habitation
- Initial EVA system & Surface Suit
- Basic Nav & Comm

Open For Global Cooperation

Systems & Capabilities Envisioned for an Outpost including:

- Long duration surface suit
- Advanced, long-duration Habitation
- Basic and Augmented Power Systems
- Basic, unpressurized rover
- Pressurized rover
- Logistics rover
- Augmented, high bandwidth satellite communication/navigation
- Logistics Resupply
- ISRU Production

Time

Participant Flexibility Strategy

- Welcome parallel capabilities while seeking "open architecture" contributions
- Continue success of Global Exploration Strategy via multilateral engagement
- Continue success of US Chamber of Commerce engagement
- Build on long-standing bilateral relationships while seeking new relationships when opportunities and conditions permit

Transition Communications

Top-Down, Bottoms-Up, In and Out Transition Communication

- Transparency, Accuracy, Clarity, Brevity: the Facts in a Timely Manner

Clear & Consistent Communication

T&R Monthly Activity Report

- Distributed broadly
- Provides a monthly snapshot of what everyone is working on
- Requires short-term goal setting
- Quick way to track progress

T&R Issue Report

- Complied for managers review at TQPMR
- Helps identify temporary vs. serious roadblocks
- Stimulates discussion about shared (or not) experiences across centers

Transition Websites: www.nasa.gov/transition

- http://sspweb.jsc.nasa.gov/webdata/spo/transition/index.htm
- ICE Portal: Transition

Strategic Comm Possibilities: NASA TV, Transition Summit, Transition Town Hall Meetings, Transition Talking Points, Transition WAR

NASA Transition Summary

- Transition is Challenging, Complex, and Dynamic
- Plans & Estimates Continue to Mature
  - NASA Transition Plan (2008)
  - Workforce Transfer & Allocation (Strategy Release in March 2008)
  - Facility Transfer/Disposal on Target (For Retirement, Closeout & Transfer)
  - Personal Property Disposition (Transfer and Excess)
- FY11+ Workforce, Shuttle Property Excess, Facility Gap budgets remain Threat
  - FY 2010 President's Budget is target for incorporation of revised T&R Budget
  - Post-Shuttle Workforce skill needs will shift -- We are preparing
  - Major facilities are transitioning today – Substantial progress already
  - Longer "Gap" = Greater difficulty in mitigating workforce & facility impacts
- NASA will Generally Spend Same Amount on Labor Nation-wide, but Change of Emphasis Toward Development of New Exploration Systems

NASA is not going out of Business, rather, Transition Enables a New Line of NASA Business for the Next 30-50 Years.

Stable CxP Funding, Minimizing Gap & Enabling Lunar Work: Keys to Success!